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Evaporation Memo ndum No.27

Water temperature, tank colour and the evaporation of fresh water from tanks.

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Introduction.

Where evaporation tanks are used "in the field" to obtain rough but useful estimates of day to day evaporative loss from bodies of fresh water and from well-watered vegetation it is not always possible to ensure, by regular cleaning, that white-painted tanks retain their reflective and absorptive qualities. Chiefly for this reason the Meteorological Office advises that the interiors of such (buried) tanks should be painted dull black.

A number of the tanks in use in Britain, including those at three Meteorological Office stations, have always been painted white. The decision to carry out a comparison was taken in 1970 and, with effect from April 1971, one of a pair of GGI 3000 tanks (approx. 61 cm in diameter and depth; buried in turfed ground with rim about 3 in (76mm) above ground) at Kew was painted black whereas the other was left white.

Analysis of evaporation data.

The two tanks had been in operation (both white) for 34 months before the two-colour trial started so it was possible to begin by investigating differences in evaporation from two identical tanks only 4.3 metres apart in the Observatory garden.
Comparisons of data from these tanks were first made by Wright (Evaporation Memorandum No.1) using data from June to November 1968.
Daily and monthly totals (of evaporation) are available from June 1968 to March 1971 (inclusive). The monthly totals are compared in Fig.1.
The slope of the line of best fit through the origin is $E = 1.031W$.
With effect from April 1971 the western tank has been painted black (inside).
Monthly totals from April 1971 to December 1972 are compared in Fig.2. The slope of the line of best fit through the origin is $E = 0.966W$.
Thus we have $E = 1.031\ W_1$

where W_1 stands for western tank painted white

and $E = 0.966\ W_2$

where W_2 stands for western tank painted black.

Combining these two equations $1.031W_1 = 0.966W_2$

or $W_2 = 1.067W_1$

Thus, by painting the inside of the western tank black it appears that we have increased evaporation from it by about 6.7%.

Analysis of water temperatures.

Floats in both tanks carry radiation-shielded maximum and minimum thermometers. Daily maximum water temperatures falling within 2°C ranges have been counted, month by month, (a) for 1970 when both tanks were white and

(b) for 1972 when the western tank had been painted black.

Numbers of cases in each range are shown in Figs. 3a and 3b.

When both tanks were white the western tank was generally warmer in January and December, there was little difference in November and the eastern tank was generally warmer in all the other months. After the western tank had been painted black, however, the water in it was generally warmer than that in the eastern (white) tank in all months.

Conclusions.

It appears that the water temperature and evaporation relationships between the two tanks were systematically reversed by changing from white to black the tank previously colder (in the months of significant evaporation) and having lower evaporative losses. The temperature and evaporation differences when both tanks were white suggest that if tanks are to be used on a network basis (to compare evaporation at various places during the same period) they should be provided with effective, standardised thermal insulation.

Met O 8 Bracknell

May 1973.

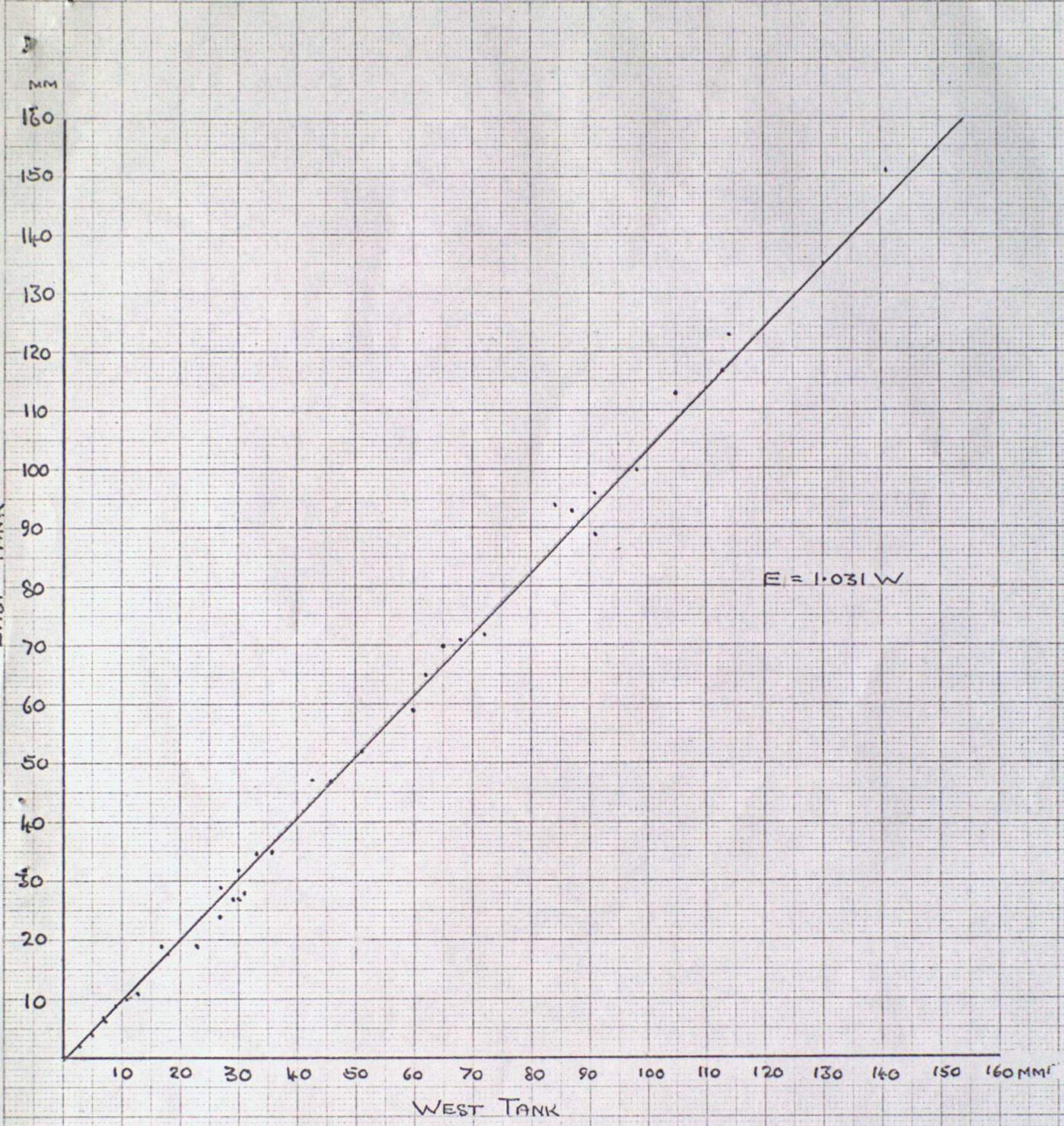

FIG. 1. MONTHLY* TOTALS OF EVAPORATION FROM TWO GGI 3000 TANKS (WHITE) AT KEW OBSERVATORY JUN 1968 – MAR 1971.

* DAYS WHEN EITHER TANK LACKED DATA WERE IGNORED

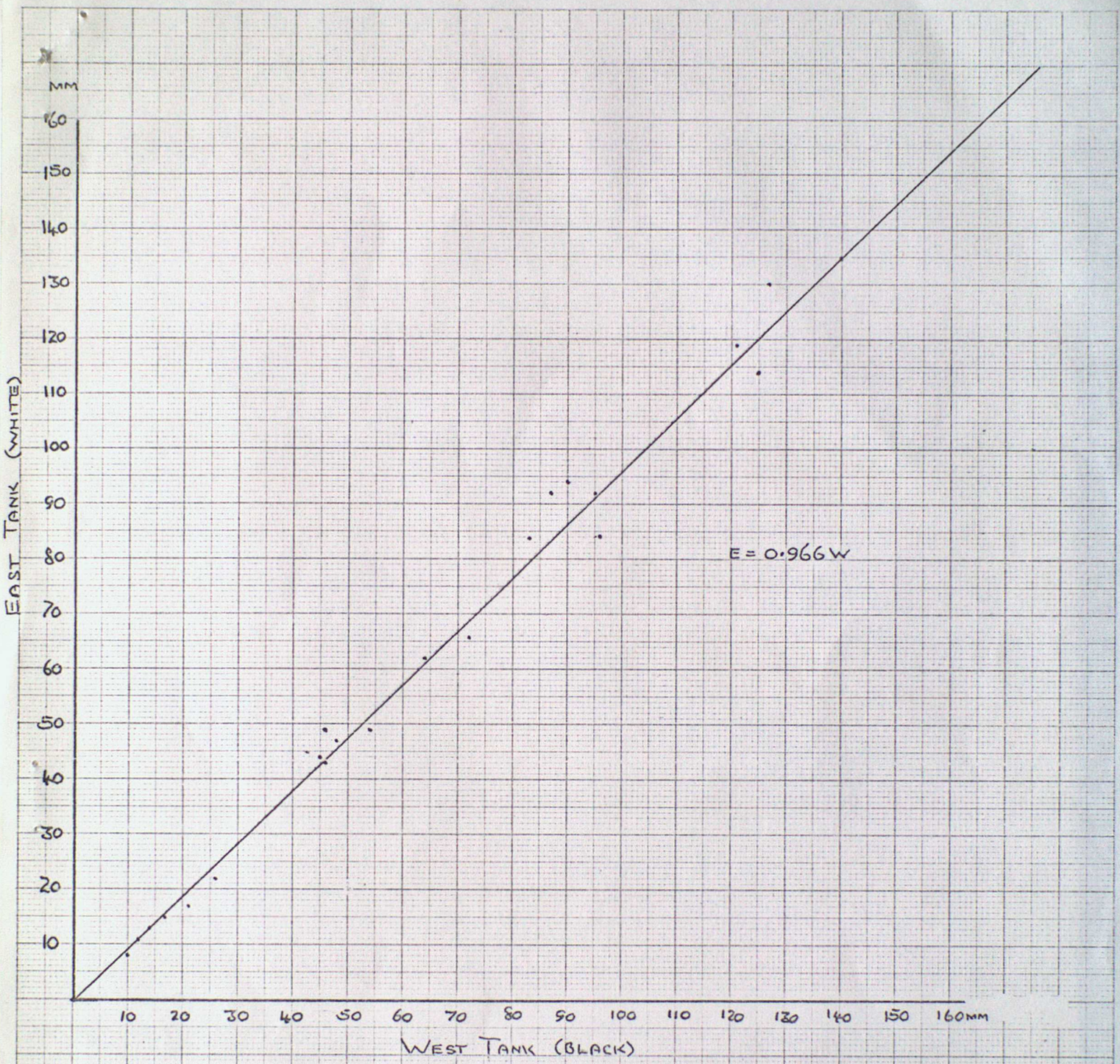

FIG.2. MONTHLY* TOTALS OF EVAPORATION FROM TWO GGI 3000 TANKS (ONE WHITE AND ONE BLACK) AT KEW OBSERVATORY APR 1971 – DEC 1972

* DAYS WHEN EITHER TANK LACKED DATA WERE IGNORED.

Comparison of Daily Maximum Water Temperatures in two GGI 3000 tanks at Kew.

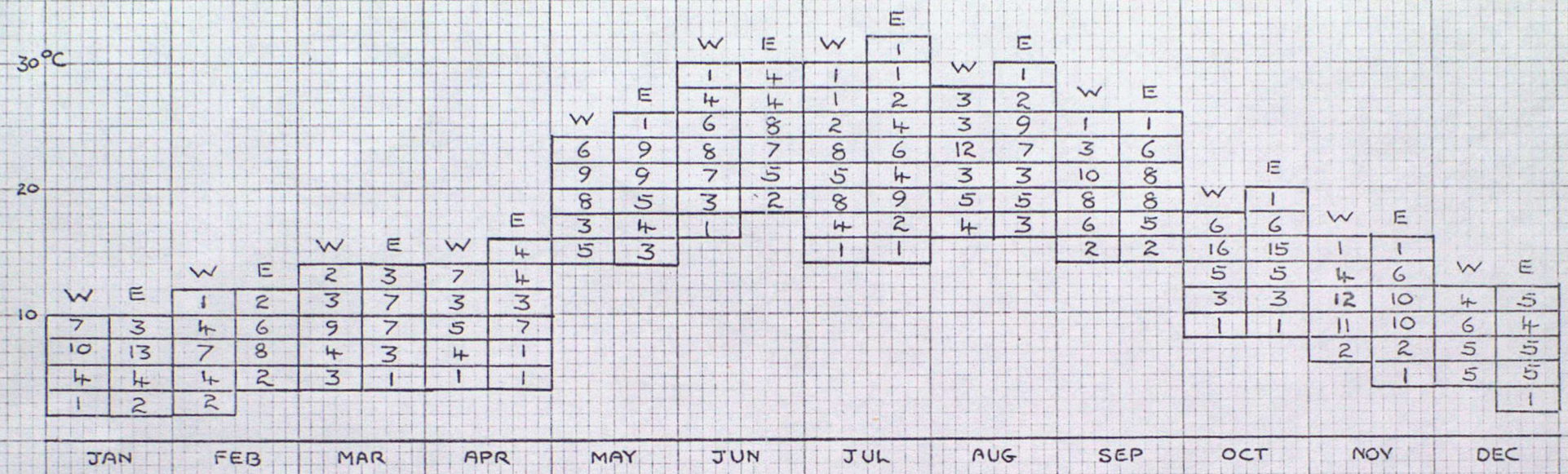

Fig. 3 (a) Distribution of Daily Maximum Water Temperatures 1970 (both tanks white)*

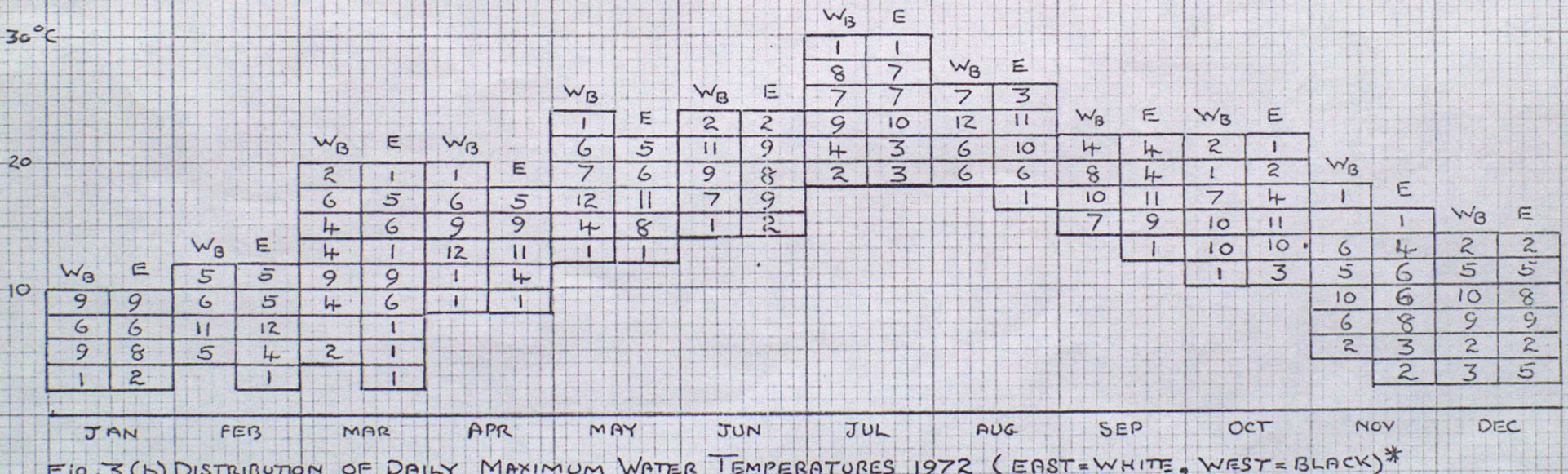

Fig. 3 (b) Distribution of Daily Maximum Water Temperatures 1972 (East = white, West = black)*

* Days when either tank lacked data were ignored.